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grams will make clear the relative positions of comet and stars at the times of measurement. The circles represent the fields of view.

Dr. M. W. MEYER made observations at Geneva of the great comet of 1881 (1881 III), from which he deduced an appreciable refraction.*

In 1891, Professors BURNHAM and BARNARD made observations at the Lick Observatory of WOLF's comet for this purpose.†

Professor BURNHAM'S measures show a slight systematic variation, but in the opposite direction from what is to be expected upon the most probable assumption of the variation of density in the comet. Professor BARNARD'S observations show no systematic deviations.

LICK OBSERVATORY, UNIVERSITY OF CALIFORNIA, 1899, July 28.

THE RADIANT POINTS OF METEORS.

BY W. H. S. MONCK.

In a paper read before the Astronomical Society of the Pacific, in November, 1892, I contended that all, or almost all, meteor-radiants were of the stationary or long-enduring kind, and that the current theory which required them to shift their position in the heavens every night during the continuance of the shower entirely failed to explain the facts. "A General Catalogue of Meteor-Radiants," by Mr. DENNING, has just been published in the fifty-third volume of the "Memoirs of the Royal Astronomical Society." Mr. DENNING is probably both the greatest living observer and the greatest collector of observations of meteors, and his tables, I think, bear out the views which I expressed nearly seven years ago to the fullest extent.

Mr. DENNING reduces all radiants hitherto observed to 278 centers. But owing to the paucity of observations made in the southern hemisphere, there are perhaps thirty of these of whose persistency or otherwise we have at present no reliable information. Omitting these, it will be found that in the vast majority of cases meteors come from the same radiant for more — often for much more — than a month in succession without any perceptible variation in the radiant. Thus, taking the first twenty of Mr. DENNING'S centers of radiation (which he places in order

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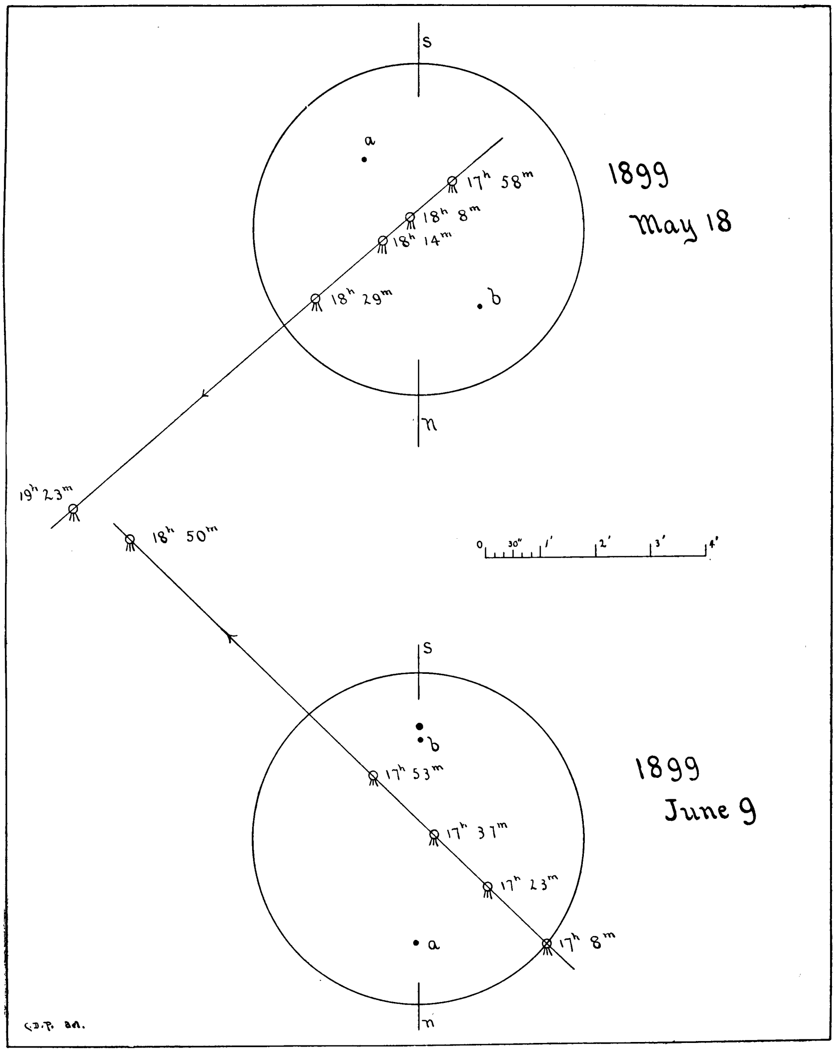
* *Astronomische Nachrichten*, No. 2471. † *Astronomische Nachrichten*, No. 3072.



THE RELATIVE POSITIONS OF SWIFT'S COMET (1899 *a*) AND COMPARISON-STARS USED IN OBSERVATIONS FOR REFRACTION.

of Right Ascension), one is a southern radiant of the kind already referred to, and the only other whose duration falls short of a month lasts for at least three weeks (a shower from near η *Aries* in October). The celebrated *Leonid* shower is one of the shortest in duration; still it continues for at least ten days without perceptible shifting, and meteors come from almost the same point from February to April, which Mr. DENNING describes as "γ *Leonids.*" The question of their identity with the great meteor-shower is worthy of consideration, when we find precisely the same features presented by the *Perseid* shower of August and the *Andromede* shower of November, both of which facts are clearly signalized by Mr. DENNING, who extends the remark to all the great showers of the year, the *Quadrantids*, the *Geminids*, the *Orionids*, and even the *Lyrids* (p. 209). As to the shifting of the *Lyrid* radiant he entertains some doubt, and the only shower of which he positively affirms this property is the *Perseid* shower in July and August, of which he gives an ephemeris. There is, no doubt, much appearance of shifting in this case, yet there are circumstances which may somewhat qualify our conclusions. The earlier positions in Mr. DENNING'S ephemeris agree with the somewhat diffused radiant of the α *Cassiopeids* (No. 7), which last from the beginning of July to December, and they are consequently repeated after the shifting radiant has passed on. We next get into the δ *Cassiopeids* (No. 15) — another diffused radiant including determinations at 20° + 50° and 17° + 51°. Then come the θ *Perseids* (No. 30) and the χ *Perseids* (No. 32). In fact, this part of the sky is almost covered with diffused radiants; and assuming the shifting to be real, it would be no easy task to segregate the meteors belonging to this shifting radiant from those belonging to the diffused stationaries over which it was passing and to obtain any determination which was not a mixture of the two. It does not appear to be asserted that the meteors belonging to the shifting radiant can be distinguished from those belonging to the stationary radiants by any physical peculiarities, nor can it be said that the shifting radiant is sharply defined while the stationaries are diffused. The coincidence of the principal position on August 10th with a stationary radiant which is active before as well as after that date has been already noticed (No. 39). Practical observers, however, generally adopt the theory of shifting, though not agreed in the position of the radiant for any particular night. It seems pretty plain that there is on the whole a continuous change (though not perfectly steady) in the point or area from which the maximum supply of meteors reaches us, but each point or area on the path thus taken by the maximum is active both before and afterwards. Taking up Mr. DENNING'S ephemeris, it may give the point from which the largest supply of meteors will probably come on the night in question, but meteors will be found coming from that point both before and afterwards — perhaps for several months. The whole problem is a very complicated one. The August *Perseids* do not appear to exhibit the periodicity which a cometary origin would lead us to expect. The swarm seems to be greatly broken up, and its present shape is probably one which our best mathematicians would be unable to deal with, even if it were accurately known. A good explanation of the ordinary phenomena of stationary radiation — *regarded not as exceptions*, *but as the almost invariable rule* — is what we require, in the first instance. Having got that, we may then inquire into the cause of the anomalous features presented by the *Perseids.* I am inclined to think that Mr. DENNING might have reduced his radiants to a somewhat smaller number than 278. But the classification of radiants is a matter of considerable difficulty. When a radiant is diffused there are often sub-radiants, and the distinction between such a sub-radiant and a neighboring diffused radiant is very slight. In this way some of the radiants which are referred to one center might with equal justice be referred to another. But considerations of this kind cannot affect the general result.

ELEMENTS OF COMET 1898 VIII (CHASE).

By ROGER SPRAGUE.

From CODDINGTON'S observations at Mt. Hamilton, 1898, November 23, and 1899, January 29, and KOBOLD'S observation at Strassburg, 1899, April 4, I have computed the following parabolic elements for Comet 1898 VIII (CHASE). The Mt. Hamilton observations were kindly furnished to the Students' Observatory by mail. The Strassburg observation was taken from the *Astronomische Nachrichten,* No. 3556, and used after applying a slight correction to the reduction to apparent place. In order to secure the greatest accuracy in the elements, especially